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PROCEEDINGS
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UPN "VETERAN" JATIM

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STIKOM BALI

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ARTICLES OF BALI INTERNATIONAL SEMINAR ON SCIENCE AND TECHNOLOGY (BISSTECH) II 2014
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	Method		

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DETERMINATION OF ORGANIC LOADING AND HYDRAULIC LOADING RATE THE ROTATING-GEARED BLADE DISCS- CONTACTOR FOR NITRATE CONTAINING ORGANIC WASTE

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ABSTRAK

Tujuan utama dari penelitian ini, adalah menentukan organic loading dan hydraulic retention time pada Rotating-Geared Blade Discs-Contactor, untuk limbah organik yang mengandung nitrat, dalam penelitian ini menggunakan limbah tempe. Penentuan kedua parameter desain tersebut, yaitu Organic Loading (OL) dan Hydarulic Loading Rate (HLR) pada model *Rotating-Geared Blade Discs-Contactor* (RgBC), adalah untuk mengetahui karakteristik reaktor RgBC dalam mengolah limbah cair industri pangan dalam hal ini industri tempe, yang limbahnya mengandung kandungan organik dan nitrat. Metoda yang digunakan, adalah mengolah limbah tempe, dengan menggunakan reaktor RgBC, dengan memvariasi parameter COD (Chemical Oxygen Demand) dan BOD (Biological Oxygen Demand), sedangkan parameter yang ditetapkan adalah pH diatur netral (6-9), suhu ruangan (25^oC-30^oC). Hasil penelitian pengolahan limbah tempe dengan menggunakan reaktor RgBC, didapatkan yang memenuhi syarat Keputusan Gubernur Jawa timur No. 45 Tahun 2002, dengan untuk menghasilkan COD effluen ≤ 300 mg/l, Organic Loading yang didapat 11.91 – 47.33 gr /m^2. hari, dan HLR 0.037 - 0.074 m^3/m^2.hari, dengan COD inlet untuk limbah tempe ≤ 2000 mg/l, yang mampu diolah oleh RgBC dengan Hydraulic Retention Time (HRT) 1.4 – 4.2 jam.

Kata kunci : limbah, nitrat, *contactor*, biologi

ABSTRACT

The main objective of this study is to determine the organic loading and hydraulic retention time on the rotating-Geared-Blade Discs Contactor, for wastes containing organic nitrates, in this study using tempe (kind of traditional food) waste. Determination of both the design parameters, namely Organic Loading (OL) and Hydarulic Loading Rate (HLR) in a model-Geared Blade Rotating Discs-Contactor (RgBC), is to determine the characteristics of RgBC reactor treating wastewater in the food industry in this industry of tempe, that wastes containing organic content and nitrate. The method used, is to process the waste of tempe, using RgBC reactor, by varying the parameters COD (Chemical Oxygen Demand) and BOD (Biological Oxygen Demand), while the parameter is set to neutral pH (6-9), room temperature (25^oC-30^oC). Results of studies using tempe wastewater treatment reactor RgBC, obtained qualified East Java Governor Decree No. 45 In 2002, the effluent COD to generate ≤ 300 mg / l, Organic Loading obtained 11.91 - 47.33 g / m^2. day, and HLR 0037-0074 m^3 / m^2.hari, with COD inlet to tempeh wastewater ≤ 2000 mg / l, which is able to be processed by RgBC with Hydraulic Retention Time (HRT) 1.4 - 4.2 hours.

Keywords: waste, nitrates, contactor, biology

1 INTRODUCTION

Currently there are many industries - industries that produce little waste with organic content and nitrates, such as soybean processing industry, food, leather tanning, and others. But the waste it generates is not processed properly, due to cost constraints and land for waste treatment, which eventually became a source of pollutants.

Rotating Geared-Blade-Discs Contactor is the development of a Rotating Biological Contactor, which is a liquid waste treatment plant with aerobic process, which consists of the discs. Development is done, is the innovation form of contactor (discs) of conventional into three-dimensional shapes, which aims to increase the supply of oxygen, where the oxygen supply is increased from serrations and parts of the disc, when the disc is rotated around the discs will create a three-dimensional flow of moving water with penetrate various parts of the disc that will increase turbulence. Medium serrations on the disc, will make a splash that would further increase the supply of oxygen to the waste. These discs, as a growing medium of microorganisms, which dipped into

wastewater and rotated slowly. Biofilms result of the growth of microorganisms that exist in the disc, lower functioning contaminants present in the waste.

The oxygen supply is an important factor in the oxygen-limited autotrophic system nitrification / denitrification (OLAND) Rotating Biological Contactor. Estimation of oxygen uptake by microorganisms 85% - 89% when the disk is exposed in the air. For the form of discs with serrated design and can be split further enhance the absorption of oxygen. And nitrate nitrogen is nitrogen in the form of the most oxidized wastewater. Nitrogen is the most important building blocks in protein synthesis, nitrogen then the data is needed to evaluate the success of wastewater treatment by biological processes.

The purpose of this study is to determine the organic loading and hydraulic retention time on the Rotating-Geared-Blade Discs Contactor, for wastes containing organic nitrates, in this study using tempe waste.

Principles of RBC

RBC (Rotating Biological Contactor) is one of the biological treatment technology. RBC consists of a series of rotating discs contactor shaped in a semi-circular container (Figure 1). The distance between the contactor to one another quite close and approximately 40% of the total kontaktornya (disc) submerged in wastewater.

Waste water regularly inserted into the vessel and the disc is rotated slowly, through this process microorganisms will grow and form a layer on the surface of the disc, called a biofilm. These biofilms will grow and attach to the surface of the disc in the form of mucus. Microorganisms is what will do the decomposition (decomposition) and removing the organic content of the waste water while spinning the disc submerged water will adsorp organic matter dissolved in the water. At the time of contact with the air biomass will mengadsorp oxygen, so it will be achieved aerobic conditions.

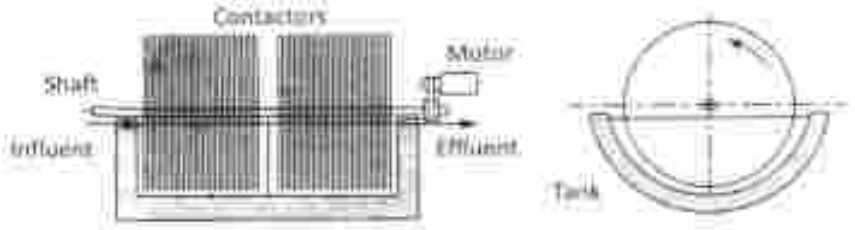

Figure 1. Rotating Biological Contactor (Tanaka 2008)

Figure 2. Model Form of Media RBC, Wave Forms, Modification and Datar (D'MBA, 2003 and Said, 2005)

In Figure 2 is some form of media that has been developed RBC, which aims to improve the efficiency of the performance of the reactor.

In figure 3, the oxygen of the air and components of BOD (organic) from waste water will be fed to the microorganism layer. The end product of the metabolism of microorganisms released into waste water and air. (Tanaka, 2008). Rotation of the disc is also a mechanism to maintain in a state of suspended biomass. Excess biomass will be carried out and deposited on the sedimentation basin II. (Metcalf & Eddy, 2003).

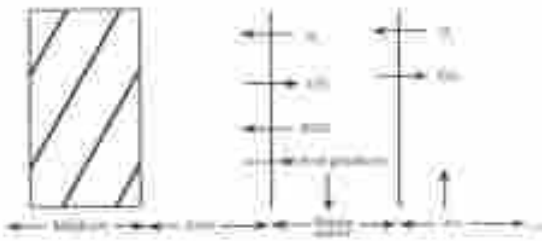

Figure 3. Schematic Representation of the Biological Film (Tanaka 2008)

Procedure Design

The main design parameters are commonly used to designate the RBC process is Organic Surface Loading, which is commonly used is the BOD (Biological Sports Surface Organic Loading, treated with RBC count and the number of surface BOD loading shared values, to obtain the surface area of the disc. Reactions in aerobic microbial depending on the concentration of organic and also on the concentration of oxygen in the system. If BOD representing organic concentration is low, BOD flux (how many grams of BOD can be reduced expand contactor surface per day) will further increase proportionately depending on the BOD. If higher concentrations of BOD, occurs lack of oxygen to process it, then it becomes stable BOD flux does not depend on the BOD of the effluent. criteria based planning Metcalf and Eddy, 2003 are: BOD removal 4-10 (g / m ^{2}. days) and BOD Removal - Nitrification 2.5 - 8 (g / m ^{2} . days).

Hydraulic Loading Rate, is a design parameter that also affects the performance RBC. Test to reduce the organic content of COD, with varying HRT (Hydraulic Retention Time), obtained from the calculation of Hydraulic Loading Rate (HLR). Planning criteria based Metcalf and Eddy, 2003, are: 0:08 to 0:16 BOD removal (m^3 / m^2. Days), and BOD removal-Nitrification 0:03 to 0:08 (m^3 / m^2 day)

2. RESEARCH METHODS

The study was conducted with RBC reactor design with three-dimensional media, which is applied on soybean waste, consisting of several stages, namely, preparation of materials and equipment, which includes the step of conditioning reactor seeding, and the acclimatization stage operational phase. Waste used in this study, is a waste of tempeh, tempeh waste with baseline characteristics fluctuate, in the range: COD = 23230 mg / l, BOD 5 = 11615 mg / l, TSS = 5500 mg / l pH = 5 NO 3 = 15.2 mg N / l.

Captive breeding of bacteria derived from industrial waste water tempe itself.
Because RGBC in laboratory scale reactor, the concentration of COD set in the range of 600 mg / l to 8000 mg / l. Nitrate TSS and COD concentrations following setting results. pH adjusted to neutral pH, the DO is measured at the time of the study. With the detention time at 0.7 hours, up to 4.2 hours.

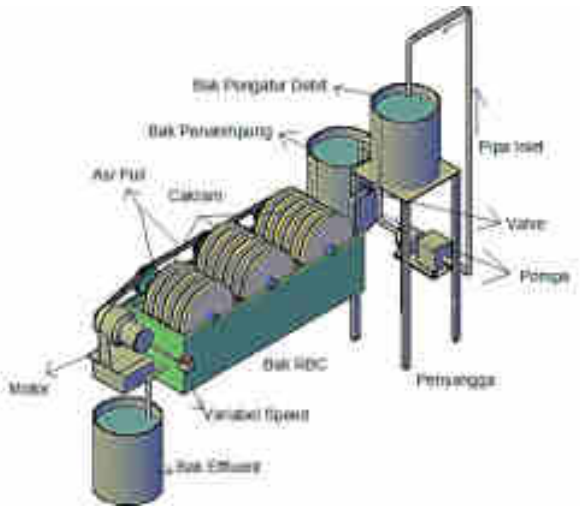

Figure 4 circuit Research Tool (1) waste water tank; (2) regulatory tub discharge, (3) pump inlet; (4). RgBC reactor; (5) RgBC discs; (6) secondary settling tanks

3. RESULTS AND DISCUSSION

3.1. Start Up RgBC

Seeding stage. On the growth of microorganisms on RBC media 3 dimensional serrated for elimination of waste organic content of tempeh, the presence of biofilm growth in media3 dimensional serrated with color biofilm attached to the media that is colored light gray vaginal discharge. Growth occurs at the time of seeding for 2 days thickness is approximately between 2.5 mm in stage 3, 2 mm in stage 2, and 1 mm in stage 3 On day 10, 12 and 14 show the thickness of the biofilm on the media 3 dimensional serrated experience decline to 2.5 mm, at this stage of biofilm thickness becomes stable, and ready made acclimatization

Acclimatization stage. At this stage of acclimatization, sewage inlet concentration, ranging varied, so that biofilms can adapt. In miroorganisme conditions on biofilm attached to the 3-dimensional media that reaches a thickness of 3 mm at the RBC stage 1, 2.5 mm in stage 2, and 2 mm in stage 3 with a surface area of RBC to 100% at each stage and the color change on biofilm layer becomes brownish white markings as it is when microorganisms adapt. but at the time of acclimation to 100% waste. At a thickness of 2.5 mm, a layer of biofilm stabilized and RBC is ready to operate.

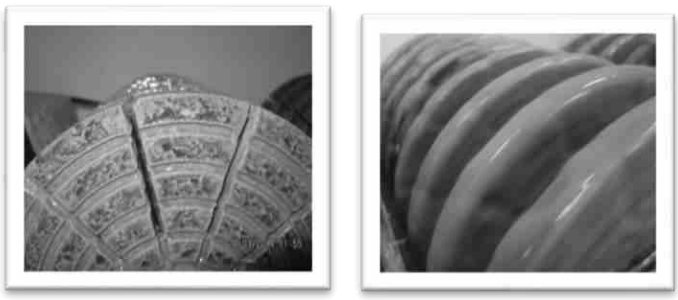

Figure 5. RgBC Photos (1) when the initial seeding, (2) the current operational

Provision Organic Parameter, Tempe Waste

The shape of 3-dimensional serrated discs at the RgBC causes the surface area of the media becomes more widespread, is designed to further improve the DO, ie the various parts of the disc so that the waste stream can penetrate various parts of the disc, sehigga waste stream is random, jagged-geriginya cause random flow in surrounding layer of microorganisms, thus increasing the dissolved oxygen more effectively and ultimately improve the performance of the tool.

The results of the analysis of the content of organic parameters tempe waste that has been processed at the RBC reactor serrated 3-dimensional media, the concentration of the input COD <2000 mg / l.dan input BOD of 1000 mg / l, which meets the requirements of East Java Governor Decree No. 45 In 2002, with the effluent standards on effluent COD of 300 mg / l. And elimination of BOD optimal ability RGBC on waste tempeh with konsenluen <150 mg / l, the efficiency is less than 2000 mg / l, the COD inlet 637.52 mg / l, BOD inlet 318.7 mg / l, detention time (td) 4.2 hours, reaching 93.27 %. For TSS parameter, the result of processing by using RGBC still not meet the required namely, achieving 62.11% per cent provision for effluent TSS results in this study, a maximum of 275 mg / l.

As for the concentration of tempe waste more than 2000 mg / l, which is the inlet COD concentration (mg / l) test: 2370, 3273.6, 4815.2, 6091.2, and 8519 mg / l, with the inlet BOD (mg / l) test: 1185, 1636.8, 2407.5, 3045.6, 4259.5, is a high concentration of organic parameters, effluent COD concentration is more than 300 mg / l. Reached 74.33% per cent allowance on HRT 4.2 h, with the inlet COD 2370 mg / l and BOD inlet 11.85 mg / l. For TSS parameter, the result of processing by using RGBC still not meet the required ie, the maximum influent of 100 mg / l. The results of the maximum effluent TSS 3600 mg / l.

Allowance Parameters Nitrate Waste Tempe

The parameter is derived from the organic nitrate nitrogen, which is an essential element for the growth of microorganisms, plants and animals. These elements are known as nutrients or biostimulan, and is the most essential nutrients. Nitrate nitrogen is a form of nitrogen in wastewater is the most oxidized. Drinking water quality standards in Indonesia limiting concentrations of nitrogen as NO 3 at a concentration of 10 mg N / l, because it can cause harmful effects on the baby.

The results of preliminary study using RGBC nitrate content, based on the variation of COD, is shown in Table 1 below.

Table 1. Concentration of NO_3^- ,Based of COD Inlet

COD initial inlet	Nitrat initial inlet		Concentration of NO_3^-					
mg/l	mg.N/l	Hydraulic Retentiun Time (hour)	0,7	1,4	2,1	2,8	3,5	4,2
637.52	0.24		0.21	0.18	0.16	0.14	0.13	0.13
844,51	0,59		0.56	0.56	0.47	0.41	0.38	0.25
1926.08	0.89		0.61	0.59	0.59	0.42	0.38	0.32
2370	0.92		0.81	0,78	0,62	0,62	0,56	0.41
3273.6	1.39		0.98	0,73	0.67	0,68	0,52	0.52
4815.2	1,71		1.62	1.62	1.55	1,46	1,42	1,42
6091,20	2.73		2.23	1,97	1.76	1,42	1.33	1,33
8519	4.02		3.51	2.90	2,65	2,58	2.35	2.17

Concentration of Nitrate , at the inlet COD variation, showed a significant decrease, although not reaching cent allowance> 80%, the maximum allowance 64% on HRT 4.2 h at concentrations 1926.08 mg / l COD. RGBC reactor works optimally at concentrations less than 2000 mg / l COD. HRT requires a longer time to be lowering nitrate, because the chemical properties of nitrogen is very complex, because the nitrogen can be assumed to have different types of oxidation number and oxidation number is, can change by the various processes taking place in living organisms pliers. Nitrate is formed, as a result of oxidation of nitrite, and nitrite to nitrate oxidation process because the oxygen supply in RGBC is the limit, then it requires a longer HRT, for high organic concentration.

Hydraulic Loading Rate (HLR)

Hydraulic Loading Rate, is one of the design parameters that affect the performance of RBC. Test to reduce the organic content of COD, with varying HRT (Hydraulic Retention Time), obtained from the calculation of Hydraulic Loading Rate (HLR), in Table 1 the formulation of a predefined volume of 17 liters divided by the surface area of 2.6 m^2 discs, and HRT were varied.

Table 2 Hydraulic Loading Rate RGBC To Waste Tempe

Remarks HRT (h)	HRT (h)					
	0.7	1.4	2.1	2.8	3.5	4.2
Hydraulic Loading Rate (m^3/m^2. hari)	0.224	0.112	0.074	0.056	0.045	0.037

The table above, which meet the criteria based Metcalf & Eddy, 2003 (0:03 to 0:08 m3 / m2.hari, for waste containing nitrogen) is at HRT 2.1 hours - 4.2 hours. And the optimal HLR by RgBC the inlet COD: 637.52 mg / l, 844.51 mg / l and 1926.08 mg / l, COD inlet concentration less than 2000 mg / l. It is related to the surface area of the reactor RGBC, whose size and scale laboratory wastes of tempe containing Nitrate.

Surface Organic Loading

Organic surface loading in research, calculated based on the results of the study with a concentration discharge of wastewater BOD know. Discharge varied research based HRT, reactor volume (V) of 17 liters, and a wide surface area (A) of 2.6 m^2, the results of the calculation are described in Table 3 Surface Organic Loading in RgBC.

Table 3. Surface Organic Loading in RgBC.

COD (mg/l)	BOD (mg/l)		Surface Organic Loading (g/m^2.day)					
		HRT (h)	0.7	1.4	2.1	2.8	3.5	4.2
637.52	318.76		71.46	**35.73**	**23.82**	**17.86**	**14.29**	**11.91**
844.51	422.26		94.66	**47.33**	**31.55**	**23.67**	**18.93**	**15.78**
1926.08	963.04		215.89	107.95	71.96	53.97	**43.18**	**35.98**
2370	1185		265.65	132.82	88.55	66.41	53.13	**44.27**
3273.6	1636.8		366.93	183.46	122.31	91.73	73.39	61.16
4815.2	2407.6		539.73	269.86	179.91	134.93	107.95	89.95
6091.2	3045.6		682.75	341.37	227.58	170.69	136.55	113.79
8519	4259.5		954.88	477.44	318.29	238.72	190.98	159.15

Optimal ability RgBC on elimination of tempe waste with concentrations less than 2000 mg / l, the HRT 4.2 hours, reaching 93.27%. This relates to the Organic Loading on industry waste, with criteria 10-50 g / m^2.day. Organic Loading that can be achieved by RGBC, cent COD removal of more than 80%, in this study, by using waste tempeh, in the range of 11.91 - 43.18 g / m^2.day. RgBC on capability of elimination tempe waste, with a concentration of over 2000 mg / l, which is the inlet COD concentration (mg / l) test: 2370, 3273.6, 4815.2, 6091.2, and 8519 mg / l, resulting in effluent COD concentration is more than 300 mg / l. This relates to the Organic Loading on industry, with criteria 10-50 g / m^2.day, rganic Loading obtained on 53.13- 954.88 g / m2.hari, organic loading exceeds the criteria set, and it is evident from the results of the study have not been optimal cent decline.

4. CONCLUSION

This reactor, works optimally on Surface Organic Loading (OSL) 11.91 - 47.33 g / m 2, day and Hydraulic Loading Rate (HLR) 0037-0074 m^3 / m^2.day, the range of numbers to waste with organic content that contain nitrates.

RgBC able to maximum COD and BOD meremoval 93.27% at 4.2 h HRT with inlet COD 637.52 mg / l. Removal efficiency of organic content by RBC reactor, in addition to optimal inlet COD 637.52 mg / l, COD inlet also to 1926.08 mg / l process of elimination 85.17% at HRT 4.2 h, while for the elimination Nitrate (NO_3^-), the HRT is only capable of 4.2 hours 64% at the concentration of 1926.08 mg / l COD inlet.

This shows RgBC capable of removing a high organic content and containing Nitrate, because the laboratory scale, and limited surface area contactor, it is necessary to set aside a longer HRT nitrate content in waste.

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